to a sound knowledge of the fundamental ideas involved. As leading towards this the author said he has always advocated personal instruction in the use and adjustment of instruments, as well as the useful practise which may be obtained in a students' surveying camp, but that before either of these is possible the student must have mastered the bedrock principles, and the author hopes that a careful perusal of the pages of the volume may help him to do this.

The book is disappointing and is not recommended to the student of engineering nor to the practising engineer as a guide or manual. It seems to be more suited to the old-fashioned county surveyor, with his Jacob's staff and Gunter's chain, for the county surveyor of today, in the United States at least, is more inclined to use the steel tape and the transit than those old instruments, which should be relegated to the museum.

The chapter on "Calculations of Distances and Heights" opens with the statement that "It is assumed that the reader has some knowledge of plane trigonometry." In this country there is probably no school teaching surveying which does not require a rather thorough course in plane trigonometry as a preliminary to the course in surveying.

Under the heading, "Levelling and Contouring" this significant statement is made: "The staff-holder should be very careful to see that the particular spot of ground upon which the staff rests is fairly flat, and if the ground is of a soft or spongy nature the spot should be pressed down with the foot." This is not teaching correct principles, for there is scarcely any leveling which should not require solid supports for the rod, and the earth, even if "*pressed down by the foot*," can not be considered a satisfactory rod support.

The short chapter on "Geodetic or Trigonometrical Surveying" is almost entirely historical and gives the student nothing which would guide him in actual work. Even the historical part does not include the recent developments and methods.

The chapter on "Geodetic Astronomy" is particularly disappointing, for it deals with only those methods which might be used in explorations and in determining the variation of the compass.

It is very difficult to see where or how such a book has any useful purpose, for there are so many other books available which are far better for both the student and the engineer.

WILLIAM BOWIE

Diabetes Mellitus. By NELLIS B. FOSTER, M.D. J. B. Lippincott and Company, 1915.

This is a model monograph for the modern practising physician. Clearly written and not too technical in language, it is still thoroughly scientific in the mode of presentation. The rapid advance in the knowledge of the fundamental biochemical processes which take place within the living body has nowhere been more pronounced than in studies concerning the nature of diabetes, a disease in which the oxidation of glucose, a substance which ordinarily furnishes two thirds of all the chemical transformations of the organism, has been impaired or totally abolished. Dr. Foster has presented all the essential details concerning the pathological chemistry of diabetes, and has at the same time written from that three-fold standpoint which controls the value of a modern medical book, personal research, personal clinical experience, knowledge of the research and clinical experience of the best authorities of the modern world. In no other book on diabetes has the value of American work been so fully recognized, and the reviewer feels that it is the best book upon the subject which has been written.

GRAHAM LUSK

SPECIAL ARTICLES

PERMEABILITY AND VISCOSITY

IN a recent article[1] Spaeth has suggested that the permeability of the surface layer of protoplasm is determined by its viscosity, which in turn depends on its colloidal condition. Increased permeability may be produced by increased colloidal dispersion, which decreases viscosity and permits substances to diffuse more rapidly into the protoplasm. An

1 SCIENCE, N. S., 43: 502, 1916.

increase of colloidal aggregation increases viscosity and causes a decrease of permeability: but if this goes beyond a certain point it produces "a decrease in the degree of intimacy between disperse phases and solvent; the fluidity is suddenly increased and diffusion across the surface is correspondingly facilitated."

Some years ago a similar conception was suggested to the writer by the fact that living tissue of *Laminaria* placed in NaCl[2] becomes much softer while in $CaCl_2$ it becomes much harder. The changes in viscosity are so great as to suggest that they are fully capable of explaining the fall of the electrical resistance of the tissue which occurs when it is placed in NaCl and also the rise of resistance which occurs in $CaCl_2$ (which is always followed by a fall of resistance).

In the hope of throwing some light upon this process sections of the tissue were observed in $CaCl_2$ under the microscope. It was then seen that after a time the protoplasm assumed a coagulated appearance: it seemed obvious that the process which increased the viscosity might produce a coagulation of the protoplasm or some other change in its structure whereby it became more permeable.

This conception led the writer to expect decreased resistance in tissues placed in NaCl (because of decreased viscosity) while in $CaCl_2$ we should expect to find increased resistance (due to increased viscosity) followed by a fall of resistance (due to coagulation or other structural change in the protoplasm).

It soon became apparent that there were several serious objections to this conception. The most important of these may be briefly stated as follows:

1. If to a solution of NaCl we add $CaCl_2$ until the increase of viscosity produced by one salt is just balanced by the decrease produced by the other, the resistance should remain stationary. This is not the case, though it seems to be so when the observations are not taken frequently enough (as happened in some early experiments). There is always a fall, or a rise followed by a fall, of resistance.

2. If more $CaCl_2$ be added there should be a rise of resistance: this should after a while become stationary, provided there is not enough $CaCl_2$ to produce the coagulation or other structural change which decreases the resistance. This does not occur: the tissue never maintains its increased resistance, but shows a fall of resistance which begins soon after the maximum is reached.

3. If still more $CaCl_2$ be added, so as to produce the coagulation or other structural change which decreases resistance, we should expect to find in all cases the same viscosity (and consequently the same maximum of resistance) just before the fall begins. Still further increase of $CaCl_2$ would only hasten this process without changing the maximum. This does not correspond with the facts. The maximum steadily rises as the proportion of $CaCl_2$ increases, so that the greatest maximum is found in pure $CaCl_2$.

4. If the fall of resistance in $CaCl_2$ is due to coagulation or to some other structural change it might be expected to be irreversible almost from the start; but this is not the case. Only when it has proceeded a good way toward the death point does it become irreversible. On the other hand the fall in NaCl (due to liquefaction) might be expected to be reversible at every stage. But it ceases to be wholly reversible after it has proceeded one sixth of the way (or less) to the death point.

5. The effect of anions on the permeability of *Laminaria* is completely at variance with their effect on the viscosity of colloids as seen in Hofmeister's series.

6. Since the changes in viscosity occur in dead as well as in living tissue we should expect to find in both cases similar changes in resistance. It is found that the decrease in viscosity in NaCl produces no appreciable effect on resistance. Even when the process proceeds so far that the tissue is reduced to a very soft jelly there is little or no change in resistance.[3] The hardening in $CaCl_2$ produces some rise in resistance, but it is much too

[2] Throughout this paper NaCl and $CaCl_2$ of the same conductivity as sea water are referred to.

[3] In a liquid a change of viscosity alters the resistance, but this is not necessarily the case in a gel.

small to account for the great changes which occur in living tissue.

It might be supposed that the reason that no change in resistance occurs in dead tissue is because the hardening and softening do not proceed as far as in living plants, but this is not the case. Moreover, it is found that the increase of viscosity in NaCl is accompanied by absorption of water, while the decrease of viscosity in $CaCl_2$ is accompanied by loss of water, and these processes take place in the same way in living and dead tissue.

It would seem that these and other important objections must be removed before we can accept the idea that changes in permeability are determined by changes in viscosity.[4]

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POLLEN STERILITY IN RELATION TO CROSSING

IN view of the recent revival of the old idea that pollen sterility is a universal and safe criterion of hybridity in plants[1] we found it of interest recently to examine the pollen of some California plants with this idea in mind.

The first species examined, *Trillium sessile* var. *giganteum,* perhaps better regarded as *T. giganteum,* a separate species from the *T. sessile* of the eastern states, is found in quantity in Strawberry Canyon, Berkeley, where it is now in full bloom. It is already known that this species shows a remarkable degree of variability, especially in the color and width of the petals. In color the petals vary from dark purple through pinks to nearly white, and also through yellows to nearly pure green. One of us is making a detailed study of these variations. The former color series, combined with the width series, is found on one hillside in Strawberry Canyon, the greenish and yellowish series occurring across the bay in Marin County. No other Trillium occurs in this canyon, but a variety of *T. ovatum* occurs along with *T. giganteum* in various parts of Marin County. The two forms are not closely related, however, and it is extremely doubtful if they ever cross. In Strawberry Canyon at any rate there is no possibility of *T. giganteum* crossing with any other species, yet some plants collected here show a considerable amount of sterile pollen.

In all the pollen examinations the grains were only considered "bad" when they were obviously shrivelled or greatly undersized, so that the amount of non-viable pollen would doubtless be considerably larger than the percentage recorded here as bad. The highest amount of bad pollen recorded from any normal plant of *T. giganteum* from Strawberry Canyon was 18.2 per cent., and the lowest 3.2 per cent. In another plant having certain abnormalities of the flower the percentage was as low as 1.5 per cent. In five plants from Camp Taylor, Marin County, where the species grows in company with *T. ovatum,* the percentages of bad pollen were respectively 7.3, 5.6, 3.9, 3.2, 2.3. Thus the amount of defective pollen is not high in any of the plants examined, with one exception, though the pollen grains are never all perfect.

The form of *T. ovatum* occurring in Marin County is remarkably uniform, in contrast with the variable *T. giganteum.* The pollen from seven plants of *T. ovatum* was examined, and they were found to have respectively 7.3, 7, 5.3, 4.5, 4.2, 3.9 and 3.9 per cent. bad pollen grains. Thus a species which is very invariable in this locality and which we can be quite certain does not cross with *T. giganteum,* nevertheless produces regularly a certain percentage of shrivelled and misshapen grains.

Still more conclusive evidence regarding the occurrence of considerable quantities of bad pollen in the absence of crossing was furnished by *Scoliopus.* This remarkably isolated genus of the Liliaceæ contains only two species, *S. Bigelovii,* which is confined to California from Santa Cruz to Humboldt County, and *S. Hallii,* which occurs in western Oregon. In plants of *S. Bigelovii* collected in Marin

4 It would appear that the term viscosity is loosely applied to a variety of phenomena which may be produced in different ways.

1 Jeffrey, E. C., 1915, "Some Fundamental Morphological Objections to the Mutation Theory of DeVries," *Amer. Nat.,* 49: 5–21, Figs. 7.